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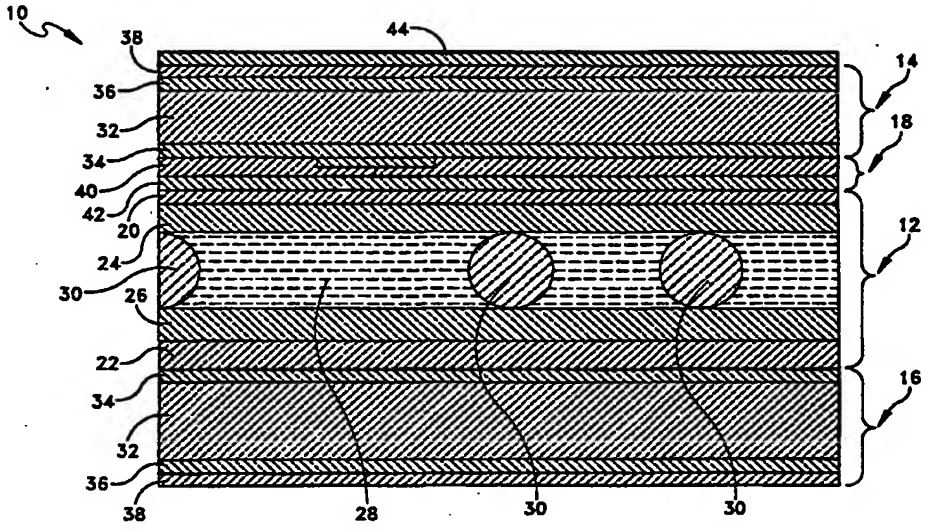
With amended claims.

(54) Title: FLAT PANEL DISPLAY WITH PARYLENE BARRIER AND PROTECTIVE FILMS



(57) Abstract

An improved flat panel display (10) is provided by replacing the various barrier films of the layered construction with thin films of polyparaxylylene (parylene). Parylene is highly transparent and provides superior chemical and electrical properties to the conventional materials used for such barrier films. In the liquid crystal panel assembly (12), the orientation films (24, 26), gate insulator (50) and etch stop layer (56) each comprise a parylene material. In the color filter (18), the color filter overcoat (42) comprises a parylene material. In the substrates (14, 16), the inner and outer barrier films (34, 36) each comprise a parylene material. The flat panel (10) is further provided with an external protective overcoat (44) comprising a parylene material. The protective overcoat (44) is believed to enhance light transmission through the panel assembly thereby increasing the brightness of the display panel.

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FLAT PANEL DISPLAY WITH PARYLENE BARRIER AND PROTECTIVE FILMS

Background and Summary of the Invention:

The instant invention relates to flat panel displays, and more particularly to the use of polyparaxylylene (parylene) as dielectric and/or barrier layers in passive and active matrix flat panel displays.

Flat panel displays have heretofore been known in the art. In this regard, a conventional flat panel display typically includes a plurality of component layers, such as a liquid crystal panel assembly, glass substrates, a color filter, etc.. Within each of the component layers are various transparent barrier layers which separate and insulate the various component layers of the display. In some cases, the barrier layers are required to function as electrical insulators. Typically, the industry utilizes materials such as SiO_2, polymide, acrylic, urethane and SiN to form the various barrier layers in flat panel displays. However, there are numerous problems associated with each of these materials and the techniques used to apply them, including high cost, non-uniform application, material waste in application methods, and poor transparency.

The instant invention provides an improved flat panel display wherein the various barrier, and protective films of the layered construction comprise thin films of

a polyparaxylylene (parylene) material. Parylene is a versatile, inert transparent polymer which can be applied in thin film conformal coatings by a vacuum deposition process. Parylene provides a highly transparent, thin film barrier layer having a highly uniform coating thickness. Parylene further has attractive dielectric properties so that it functions as an excellent electrical insulator. The flat panel display comprises a liquid crystal panel assembly, first and second substrates positioned on opposing sides of the liquid crystal panel and a color filter disposed between the first substrate and the liquid crystal panel. The liquid crystal panel includes first and second electrode members each having an orientation film disposed on an inwardly facing surface thereof, a gate insulator adjacent the second electrode member, and a plurality of thin film transistors on the second electrode member. In the liquid crystal panel assembly, the orientation films, gate insulator and etch stop layer of the thin film transistor each comprise a parylene material. The color filter comprises a color filter layer and a color filter overcoat comprising a parylene material. The substrates comprise a glass panel, and inner and outer barrier films each comprising a parylene material. The flat panel is further provided with an external protective overcoat comprising a parylene material. The protective overcoat

is believed to enhance light transmission through the panel assembly thereby increasing the brightness of the display panel.

Accordingly, among the objects of the instant invention are the provision of a flat panel display wherein the inner and outer barrier films of the glass substrate comprises parylene; the provision of a flat panel display wherein the gate insulator and etch stop layer of the liquid crystal panel assembly comprise a parylene material; the provision of a flat panel display wherein an orientation film comprises a parylene material; the provision of a flat panel display wherein a color filter overcoat layer comprises a parylene material; and the provision of a flat panel display wherein an external coating comprises a parylene material.

Other objects, features and advantages of the invention shall become apparent as the description thereof proceeds when considered in connection with the accompanying illustrative drawings.

Description of the Drawings:

In the drawings which illustrate the best mode presently contemplated for carrying out the present invention:

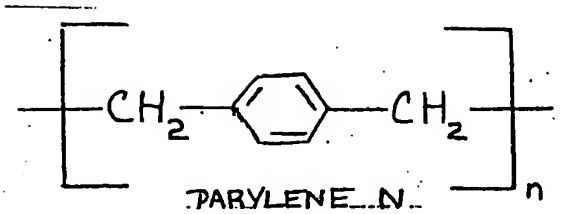
Fig. 1 is a cross-sectional view of a passive flat panel display in accordance with the instant invention;

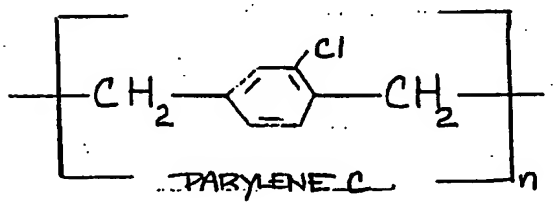
Fig. 2 is a cross-sectional view of an active matrix color flat panel display in accordance with the instant invention; and

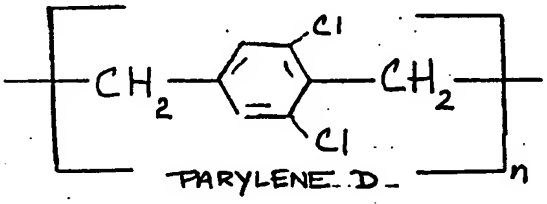
Fig. 3 is an enlarged cross-sectional view of a thin film transistor of the display panel of Fig. 2.

Description of the Preferred Embodiment:

Referring now to the drawings, a passive flat panel display assembly in accordance with the instant invention is illustrated and generally indicated at 10 in Fig. 1. As will hereinafter be more fully described, the instant flat panel display 10 includes a plurality of dielectric and barrier layers which comprise a polyparaxylylene material. Polyparaxylylene is a highly transparent polymer composition which provides superior chemical and electrical properties to the conventional materials used for various barrier films and dielectric layers. Polyparaxylylene (parylene) is commercially available from Alpha Metals, Inc. and is sold in various formulations including "Parylene N", "Parylene C" and "Parylene D" having the following formulas.

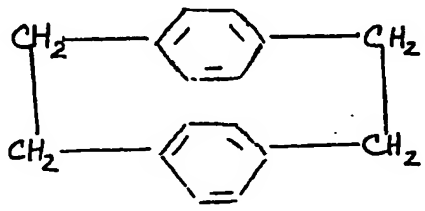




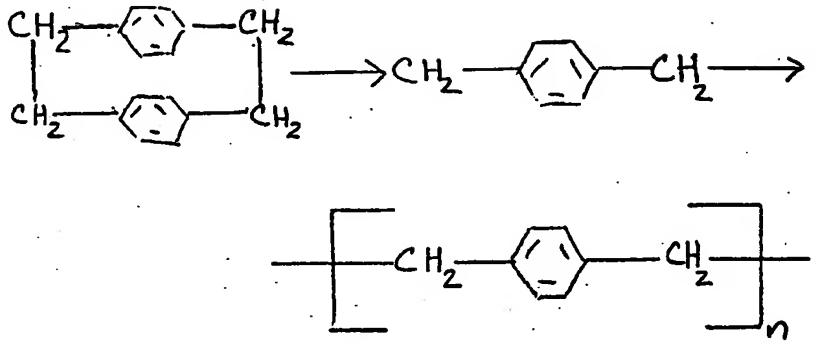


Parylene is also available in numerous of other variations, including a fluorinated parylenes. Any one of described parylene formulations, or any other derivative thereof, is suitable for use in the instant invention. Accordingly, for purposes of this specification, the term "parylene" is intended to means polyparaxylylene or any one of its derivative forms.

Parylene is typically deposited in a thin film onto a substrate using a vacuum vapor deposition method wherein a parylene dimer of the formula:



is split into its monomer form according to the following reaction:



Briefly, a powdered form of the parylene dimer is vaporized in a vaporization chamber, and then the vaporized dimer is split into its monomer form in a pyrolysis chamber. The monomer vapor is then fed into a vacuum chamber in which a substrate to be coated is located. The parylene vapor then settles onto the substrate in a very even, conformal coating. Various thicknesses of coating can be achieved by known means. In any event, the parylene coating processes are well known in the art, and will not be described further.

Referring again to Fig. 1, the flat panel display assembly 10 comprises a liquid crystal panel assembly generally indicated at 12, first and second transparent substrates generally indicated at 14, 16 and respectively

positioned on opposing sides of said liquid crystal panel 12, and a color filter generally indicated at 18.

The liquid crystal panel 12 comprises first and second transparent electrode members 20, 22 each having an orientation film 24, 26 disposed on inwardly facing surfaces thereof. The transparent electrode members 20, 22 preferably comprise indium tin oxide, and the orientation films 24, 26 preferably comprise a parylene material. The liquid crystal panel 12 further comprises a liquid crystal material 28, such as a noematic liquid crystal composition, received between the first and second electrode members 20, 22. The liquid crystal material 28 is provided with plastic or glass spheres 30, or spacers, which serve to space apart the electrodes. The liquid crystal panel 12 is operative in a conventional manner wherein the parylene orientation films 24, 26 facilitate alignment of the crystals when an electric field is generated in the liquid crystal panel 12.

Each of the transparent substrates 14, 16 comprises a flat glass panel 32, inner and outer barrier films 34, 36 respectively disposed on inner and outer surfaces of the glass panel 32, and a polarizing film 38 disposed on an outer surface of the outer barrier film 36. The inner and outer barrier films 34, 36 comprise a parylene material.

The color filter 18 comprises a color filter layer 40, and a color filter overcoat 42. The color filter layer 40 is conventional in the art, and is fashioned by known dyeing, printing or electrodeposition methods. The color filter overcoat 42 comprises a parylene material.

The flat panel display 10 is further provided with a protective overcoat 44 applied on the outer surface of the polarizing film 38 of the first substrate assembly 14. The protective overcoat 44 provides a protective coating to the flat panel display 10. However, the coating 44 has also been found to provide an unexpected function of increasing light transmission through the panel. It is estimated that up to 20% more light is transmitted through the panel assembly 10 due to the external parylene coating 44. This light enhancing effect is primarily due to a symmetrical alignment of the parylene molecules in the coating 44 which effectively act as light concentrators, drawing in light from a wide area and focusing that light into the flat panel. The overall effect is a brighter, more vivid screen display, which can be achieved with a less powerful light source.

Referring now to Fig. 2, an active matrix flat panel display is generally indicated at 46. The active matrix panel 46 is generally similar to the passive matrix display 10 with the exception of a plurality of thin film transistors generally indicated at 48, and a gate

insulator 50. Referring to Figs. 2 and 3, the thin film transistors 48 comprise a gate metal layer 52, comprising a metal such as Cr, Ti, W, Mo, Al or Ta, an OHMIC contact 54, an etch stop layer 56, and a source/drain metal layer 58. The etch stop layer 56 of the thin film transistor is formed from a parylene material. Furthermore, the gate insulator 50 also comprises a parylene material. Construction of the thin film transistors is otherwise conventional and known in the art.

It can therefore be seen that the instant invention provides novel and effective flat panel display assemblies 10, 46 which are less expensive to produce, and which has a better transparency than the prior art flat panels. The various parylene layers of the flat panel displays provide highly transparent, conformal layers in the panels which effectively transmit light, while offering superior electrical and chemical properties than the prior art materials. For these reasons, the instant invention is believed to represent a significant advancement in the art which has substantial commercial merit.

While there is shown and described herein certain specific structure embodying the invention, it will be manifest to those skilled in the art that various modifications and rearrangements of the parts may be made without departing from the spirit and scope of the

underlying inventive concept and that the same is not limited to the particular forms herein shown and described except insofar as indicated by the scope of the appended claims.

Claims:

1. A flat panel display comprising a liquid crystal panel, and first and second transparent substrates positioned on opposing sides of said liquid crystal panel, said liquid crystal panel comprising first and second transparent electrode members each having an orientation film disposed on inwardly facing surfaces thereof, said liquid crystal panel further comprising a liquid crystal material received between said first and second electrode members, each of said transparent substrates comprising a glass panel, inner and outer barrier films disposed on inner and outer surfaces of said glass panel, and a polarizing film disposed on an outer surface of said outer barrier film.

2. In the flat panel display of claim 1, said inner and outer barrier films comprising a parylene material.

3. The flat panel display of claim 1 further comprising a protective overcoat disposed on an outer surface of a polarizing film of one of said transparent substrates, said protective overcoat comprising a parylene material.

4. A transparent substrate for use in a flat panel display comprising a glass panel, inner and outer barrier films disposed on inner and surfaces of said glass panel,

and a polarizing film disposed on an outer surface of said outer barrier film, said inner and outer barrier films comprising a parylene material.

5. The transparent substrate of claim 4, further comprising a protective overcoat disposed on an outer surface of said polarizing film, said protective overcoat comprising a parylene material.

6. An active matrix flat panel display comprising an active matrix liquid crystal panel, first and second transparent substrates positioned on opposing sides of said liquid crystal panel, and a color filter panel positioned between said liquid crystal panel and said first substrate, said liquid crystal panel comprising first and second transparent electrode members each having an orientation film disposed on inwardly facing surfaces thereof, said liquid crystal panel further comprising a liquid crystal material received between said first and second electrode members, said liquid crystal panel still further comprising a plurality of thin film transistors disposed on said second electrode member, and a gate insulator disposed on an outwardly facing surface of said second electrode member, each of said transparent substrates comprising a glass panel, inner and outer barrier films disposed on inner and outer

surfaces of said glass panel, and a polarizing film disposed on an outer surface of said outer barrier film.

7. In the flat panel display of claim 6, said gate insulator comprising a parylene material.

8. In the flat panel display of claim 6, said thin film transistors each having an etch stop layer, said etch stop layer comprising a parylene material.

9. In the flat panel display of claim 7, said thin film transistors each having an etch stop layer, said etch stop layer comprising a parylene material.

10. In the flat panel display of claim 7, said orientation films comprising a parylene material.

11. In the flat panel display of claim 9, said orientation films comprising a parylene material.

12. In the flat panel display of claim 6, said color filter overcoat comprising a parylene material.

13. In the flat panel display of claim 6, said inner and outer barrier films of each of said substrates comprising a parylene material.

14. The flat panel display of claim 6 further comprising a protective overcoat disposed on an outer surface of a polarizing film of one of said transparent substrates, said protective overcoat comprising a parylene material.

15. In the flat panel display of claim 6, said orientation films, said gate insulator, said color filter overcoat, and said inner and outer barrier films each comprising a parylene material.

16. An active liquid crystal panel for use in a flat panel display comprising:

a first and second transparent electrode members each having an orientation film disposed on an inwardly facing surface thereof;

a plurality of thin film transistors disposed on said second transparent electrode, each of said thin film transistors comprising an etch stop layer, said etch stop layer comprising a parylene material.

a liquid crystal material disposed between said first and second electrode members;

a gate insulator disposed on an outer surface of said second electrode member, said gate insulator comprising a parylene material.

17. In the liquid crystal panel of claim 16, said orientation layers comprising a parylene material.

18. A color filter for use in a flat panel display comprising a color filter layer and a color filter overcoat layer, said color filter overcoat layer comprising a parylene material.

AMENDED CLAIMS

[received by the International Bureau on 10 October 1996 (10.10.96); original claims 1 and 6 amended; original claims 2 and 7 cancelled; remaining claims unchanged (2 pages)]

1. A flat panel display comprising a liquid crystal panel, and first and second transparent substrates positioned on opposing sides of said liquid crystal panel, said liquid crystal panel comprising first and second transparent electrode members each having an orientation film disposed on inwardly facing surfaces thereof, said liquid crystal panel further comprising a liquid crystal material received between said first and second electrode members, each of said transparent substrates comprising a glass panel, inner and outer barrier films disposed on inner and outer surfaces of said glass panel, and a polarizing film disposed on an outer surface of said outer barrier film, wherein the inner and outer barrier films comprise a parylene material.

3. The flat panel display of claim 1 further comprising a protective overcoat disposed on an outer surface of a polarizing film of one of said transparent substrates, said protective overcoat comprising a parylene material.

4. A transparent substrate for use in a flat panel display comprising a glass panel, inner and outer barrier films disposed on inner and surfaces of said glass panel,

surfaces of said glass panel, and a polarizing film disposed on an outer surface of said outer barrier film, wherein said gate insulator comprises a parylene material.

8. In the flat panel display of claim 6, said thin film transistors each having an etch stop layer, said etch stop layer comprising a parylene material.

9. In the flat panel display of claim 7, said thin film transistors each having an etch stop layer, said etch stop layer comprising a parylene material.

10. In the flat panel display of claim 7, said orientation films comprising a parylene material.

11. In the flat panel display of claim 9, said orientation films comprising a parylene material.

12. In the flat panel display of claim 6, said color filter overcoat comprising a parylene material.

13. In the flat panel display of claim 6, said inner and outer barrier films of each of said substrates comprising a parylene material.

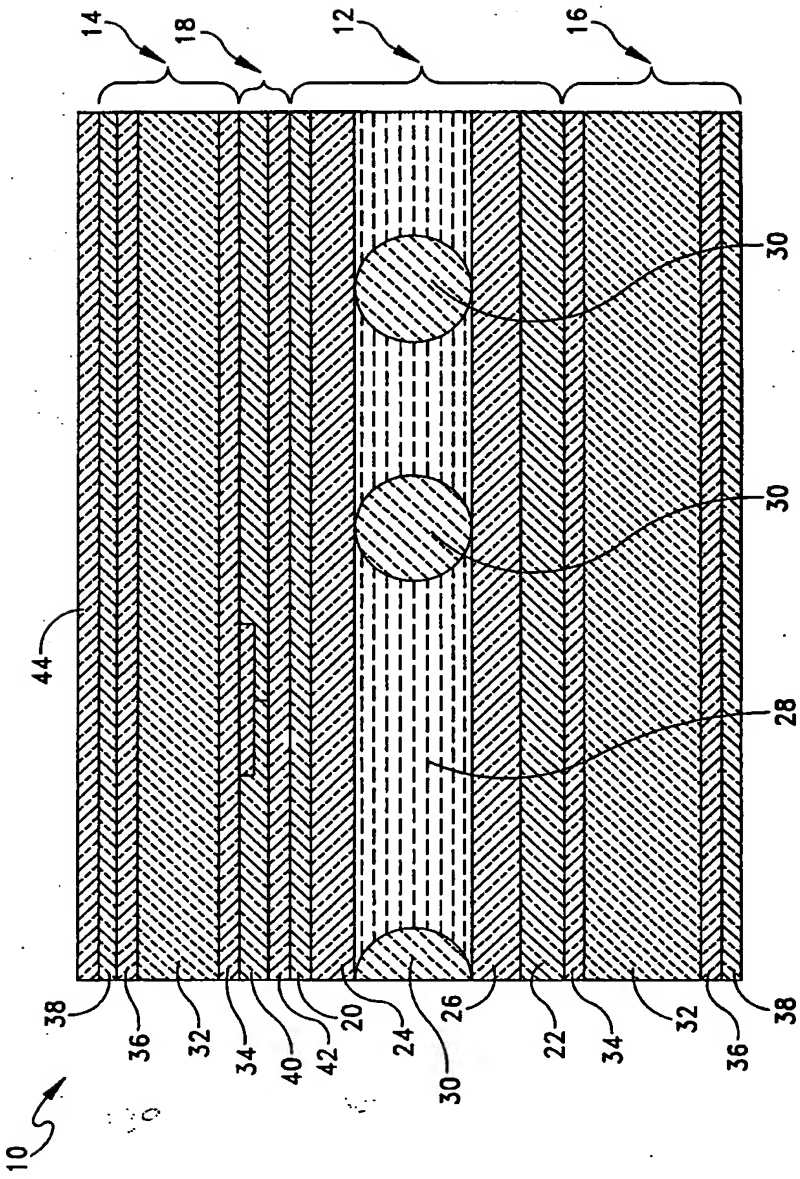


FIG. 1

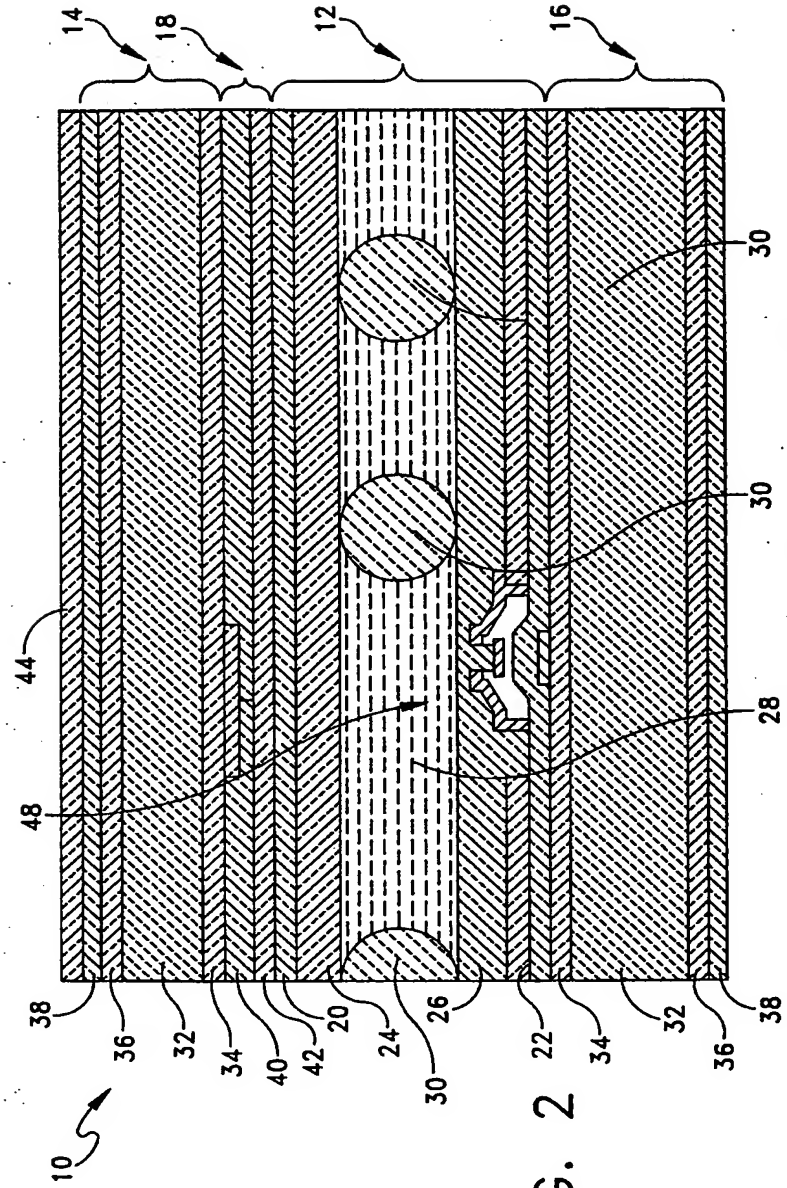

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FIG. 2

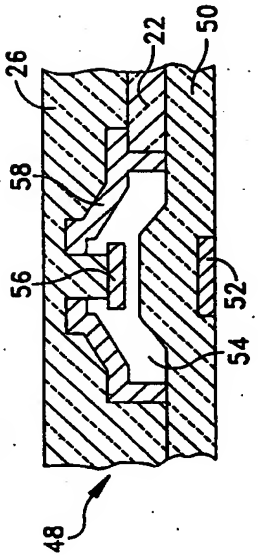
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FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/06218

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G02F 1/1333, 1/136
US CL :359/59, 63, 68, 74, 75, 79, 82

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 359/59, 63, 68, 74, 75, 79, 82

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

USPTO APS "polyxylylene or parylene or poly-para-xylylene", "etch stop", "barrier film", "protective overcoat", "gate insulating", "overcoat", "orientation film", "color filter"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	EP, A, 0 226 218 (CANON KK) 24 June 1987, page 6, lines 15-31, figure 7.	18 --- 12, 15
Y	US, A, 5,177,475 (STEPHANY ET AL) 05 January 1993, column 10, lines 4-59.	1-17
Y	US, A, 4,425,030 (SCHMIDT) 10 January 1984, column 2, lines 25-47, column 3, line 26 - column 4, line 43.	2-6, 13-15
Y	US, A, 5,245,457 (FUKUCHI) 14 September 1993, column 1, lines 16-50, figure 4.	1-15
Y	US, A, 5,045,753 (KATAYAMA ET AL) 03 September 1991, column 1, line 57 - column 2, line 47, column 6, lines 53-56, column 7, lines 35-42, figure 8B.	6-17

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/06218

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 5,064,165 (JERMAN) 12 November 1991, column 9, lines 20-68.	8, 9, 16, 17
Y	JP, A, 53-68098 (ASAHI GLASS KK) 17 June 1978, figure 6, abstract.	1-15
Y	JP, A, 64-37872 (SEIKO EPSON CORP) 08 February 1989, figure 1 element 6, abstract.	7, 15, 16